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ORIGINAL ARTICLES

Assessment of the burden of critical illness in a rural Botswana hospital with the use of an early warning score

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Abstract

Background: There is little data on prevalence of critical illness in Sub Saharan Africa, especially in rural areas, but it is needed to develop critical care services in district hospitals.
Methods: We sought to determine the prevalence of patients 'at risk of' critical illness using an Early Warning Score (EWS) in a district hospital in Botswana. During two-month period patients daily vital signs were recorded and EWSs calculated on adult medical or surgical wards to identify patients who scored ≥3.
Results: EWS on 826 patients were obtained. There were 180 patients with ≥3 [8 refused to give consent and were excluded] with mortality 63(37%) and 646 patients scored below 3, mortality of 3 (0.6%). Patients with scores ≥3 were medical (63%), surgical (27%) and orthopaedic (9%). Of patients that were transferred to a referral centre [6 (3%)], none were admitted to ICU. Patients who died lived for 6.5 (SD 7.0) days after first score of ≥3. HIV prevalence among patients that died was 37%. Other co-morbidities were rare, except hypertension (21%). Cause of death was not clear in 60% of patients. When cause of death could be inferred from clinical records, it was illness related in 75% of cases.
Conclusions: Using the EWS we have identified the burden of critical illness in a rural district hospital in Botswana and the 'critical care gap' where patients do not get the intensive care they need.

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Introduction

Critical care in Africa is restricted to major centres which are located in urban areas. This is also the case in Botswana where the 15 critical care beds in the public sector are concentrated in the two referral hospitals in the main cities. The only two private hospitals with ICU are situated in the capital. Most of the population however accesses the health care system through one of the primary or district hospitals that lack critical care services. These hospitals depend on referring severely ill patients but transfer services are poorly developed and the distances are long. Some patients are too unstable to be transferred and need to be resuscitated first, for which adequate resources are lacking as well. This is important as the lack of critical care support can affect the outcome for these patients in terms of survival.

It is not a unique situation in Africa however.[1] Provision of intensive care is still very underdeveloped in many parts of the world and has been identified as among the weakest parts of the health system.[2] This is especially the case in rural and district hospitals where the majority of patients are treated.[3] In most places the care that critically ill patients receive in hospital is informal and uncoordinated.[4] The challenge of providing critical care in Africa seems to be insurmountable.[5] Even South Africa struggles to provide critical care services in rural areas.[6]

So far the need for critical care in a rural population

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has never been established in Sub-Saharan Africa and there is no information about critical illness prevalence and outcome in Botswana. Several systems for identifying the critically ill patient have been developed and can identify the patient at higher risk of death.[7-8] Diagnosing critically ill patients according to organ failure is difficult however in a resource poor setting as the required parameters cannot be obtained due to lack of diagnostic facilities. The Early Warning Score and modified versions of it, combines the ability to predict the risk of death or intensive care admission while at the same time being simple to calculate from routinely collected data.[9-10] It is a simple bedside tool that can be calculated by nursing staff and used as a surrogate measure to estimate the population 'at risk' of critical illness.

Materials and Methods

The study was approved by the Mahalapye Hospital Ethical Review Board, the University of Botswana Office for Research and Development and the Botswana Ministry of Health. Each patient who scored 3 or more on the Early Warning System, or their next of kin was requested to give consent for their data to be collected daily.

Mahalapye Hospital is a 270 bedded district hospital with a catchment area of nearly 100,000 in rural Botswana. It has no ICU and is more than 200 km away from the nearest referral centre. We sought to determine the prevalence of patients being 'at risk' of critical illness by doing a prospective observational study. The second aim of the study was to look at outcomes in terms of death or survival when these patients have no direct access to critical care facilities.

An 'at risk' population was prospectively identified with the use of an Early Warning Score (EWS). This system was recently introduced in the hospital to identify patients at risk of clinical deterioration. The EWS has been validated as a predictor of outcome in medical and surgical patients in a developed health care setting.[11-13] It identifies those at risk of intensive care admission, cardio-respiratory arrest and death. It has also been validated on medical admissions in a rural Sub-Saharan African hospital setting where it was found to reliably predict mortality.[14]

The score allocates a number to the 5 vital signs (heart rate, systolic blood pressure, respiratory rate, temperature and conscious level) from 0 to 3 according to an algorithm and depending on the deviation from normal. The total of these 5 parameters constitute the EWS and varies from 0 to 15with more abnormal physiological parameters attracting a higher score. For the purpose of the study, the EWS algorithm was slightly altered to accommodate for the fact that temperatures measured were axillary temperatures. Therefore the temperature limits were reduced by one degree Celsius in each category (Table I). Every patient with a EWS of 3 or higher was recruited after informed consent. This was to identify a> 10% risk of death, cardio-respiratory emergency or ICU admission [9].

Table I: Early warning score as used during the study.

	3	2	1	0	1	2	3
Heart rate		0-39	40-50	51-100	101-110	111-130	≥131
Blood pressure	≤69	70-80	81-100	101-200		≥201	
Respiratory rate		≤8		9-14	15-20	21-30	≥31
Axillary Temperature		≤33.9		34-37.5		≥37.6	
Conscious level				Alert	Responding to voice	Responding to pain	Unresponsive

The Early Warning Score uses five physiological parameters which are routinely measured during daily nursing care. They have been modified for different settings eg Obstetrics, Paediatrics and for different hospital settings, such as with Medical Emergency Teams or ICU outreach. This EWS uses axillary temperature and the temperature is set 1.0 °C lower than tympanic membrane temperature.

Patients were recruited from the adult medical and surgical wards during a two months period (August till September 2011). Gynaecologic and female general surgical patients were analysed together as they were admitted to the same ward. Daily EWS were calculated from the morning vital signs by the nursing staff. For patients that scored 3 or more, the score was re-calculated by the investigators from the vital signs taken by the nursing staff to assure accuracy. If EWS scores were not calculated, the investigators would calculate the EWS for every patient on that ward for that day from the available vital signs. If vital signs were not complete an EWS score was calculated based on the available data. Although the investigators did not recheck the vital signs, aberrant results were compared with the previous and following measurements. The EWS was then based on the most likely reading.

Patients were followed up until transfer, discharge or death during hospital admission. If the patient was referred for higher-level care, efforts were made to determine the outcome in terms of hospital survival or death. Admission EWS was calculated from the vital signs recorded in the clinical notes. The maximal EWS was determined from the daily EWS during the whole admission period. Other data that were collected

included specialism, involvement of a second specialism, length of stay and survival, diagnosis and co-morbidities, reason for local treatment or transfer, decisions to restrict or withdraw care and cause of death. Data were taken from the clinical records. All patients were managed according to the local standards of care and no further investigations were requested. Total admissions, transfers and deaths were determined from ward registers and the hospital's computerized Integrated Patient Management System (IPMS). Collected data were entered into an Epi-Info data base for descriptive statistics.

Results

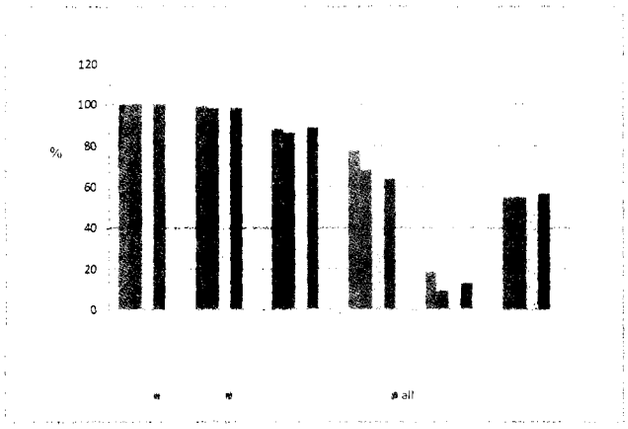
On 6264 out of 6365 patient admission days (98%) during this period vital signs were taken and in 5645 (89%) a complete set was available. Nursing staff calculated an EWS on 4042 (64%) occasions. Of the 509 EWS (13%) that were calculated as 3 or more only 292 (57%) were calculated correctly (Table II and Figure I).

Table II: Consistency and reliability of EWS calculated during the study period. Values are number of observation and percentage.

	Medical	%	Surgical	%	Orthopaedic	%	All patients	%
Number of bed Days	1994	100	1901	100	2470	100	6365	100
Number of daily Vital signs done	1974	99	1866	98	2424	98	6264	98
Number of Complete vital Signs taken	1760	88	1663	87	2249	91	5645	89
Number of EWS Calculated by Staff*	1550	78	1284	68	1208	50	4042	64
Number of EWS ≥3 calculated by Staff†	318	18	122	9	69	5	509	13
Number of Correctly Calculated EWS >3‡	176	56	75	60	41	53	292	57

The total number of bed days represents the total number of possible daily vital signs sets. Completeness of sets was between 87-91%. Calculation of EWS was done by staff between 50-78%. Calculation for those with score≥3 fell dramatically to between 5 -18%. Between 53-60% of these were correctly calculated.
***Expressed as the ratio of number of bed days. †Expressed as the ratio of number of EWS calculated by staff. ‡Expressed as the ratio of number of EWS≥3 calculated by staff.**

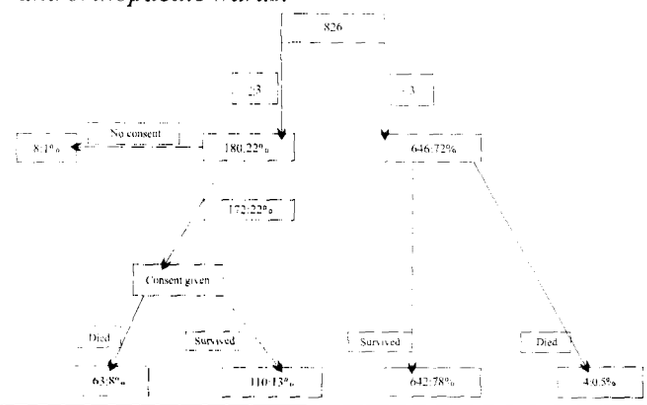
Figure I: Consistency and reliability of EWS calculated during the study period. Values are percentage of observation.



[See table II] The total number of bed days represents the total number of possible daily vital signs sets [100%]. Completeness of sets was between 87-91%. Calculation of EWS was done by staff between 50-78%. Calculation for those with score ≥3 fell dramatically to between 5 -18%. Between 53-60% of these were correctly calculated. *Expressed as the ratio of number of bed days.†Expressed as the ratio of number of EWS calculated by staff. ‡Expressed as the ratio of number of EWS≥3 calculated by staff.

A total of 826 patients were admitted of whom180 (22%) had an EWS of 3 or more and were therefore considered 'at risk' for critical illness. Eight [8] patients (2 male medical and 6 female medical) refused consent, so 172 were recruited into the study. Patients that did not reach a score of 3 or more during their admission were646 and were not included in the study arm. A total of 67 patients (8.1%) died of whom 63 (94%) were in the study arm. Mortality in patients who had an EWS of 3 or more was higher (63, 37%) than in the patients whose score stayed below 3 (4, 0.6%). Nine [9] patients were transferred of whom six [6] had scores ≥3 and were included in the study, 3 of them died (Table III).

Figure II: The study population from medical, surgical and orthopaedic wards.



Of the 826 patients367 (44%) were medical admissions, 269 (33%) surgical and 190 (23%) orthopaedic.

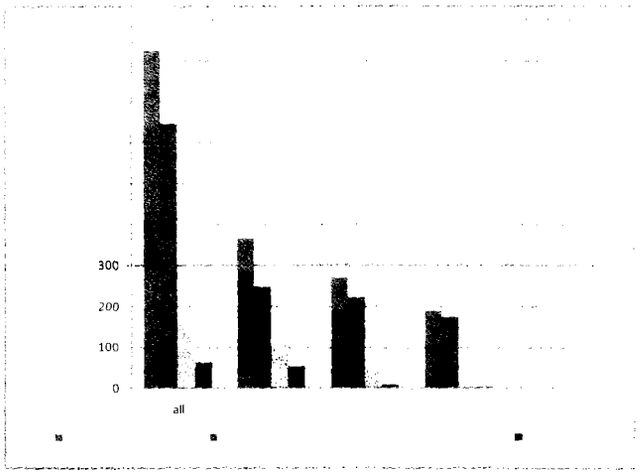
Patients that had an EWS of 3 or higher were medical patients (110;64%), surgical patients (47; 27%) and orthopaedic patients (15; 9%). This would give a prevalence of being 'at risk' for critical illness of 30% medical, 17%surgicaland 8%orthopaedic patients. Overall mortality for each discipline was highest among the medical patients (53/377;14%), surgical (7/269; 3%) and orthopaedics (3/190; 2%). In the subgroup of patients with EWS of ≥3 these mortality rates were even higher. (Table III).

Table III: Numbers of patients admitted to each service and EWS (%).

	All	%	Medical	%	Surgical	%	Orthopaedic	%
Number of admissions	826	100	367	44	269	33	190	23
Number with EWS <3	646	79	249	39	222	34	175	27
Number with EWS ≥3	172	21	110	64	47	27	15	9
Number died	63	8	53	84	7	11	3	5

Numbers of patients admitted and deaths to each service with (%).

Figure III: Numbers of patients admitted to each service and EWS.



Of the study patients 92 were female (53%) with a median age of 36 (IQR 27-58) and 80 were male (47%) with a median age of 52 (IQR 37-71). The patients that died were more often male (54% against 42%) and older (median age 59 (IQR 40-82) versus 36 (IQR 27-54). The EWS on admission (2.7, SD 1.7 versus 2.9, SD 1.8) and inclusion (4.5, SD 1.7 versus 3.9, SD 1.3) were similar for the survivors and non-survivors but the maximal (5.5, SD 1.8 versus 4.4, SD 1.5) and final EWS (4.3, SD 2.3 versus 1.8, SD 1.0) were higher in those that died. The length of hospital stay was 12 days (SD 15) for patients that died and 16 days (SD 17) for patients that died (Table IV).

Table IV: Demographic and length of stay data of the study population. Values are mean (SD) or median (IQR).

	All patients EWS ≥3		Patients with EWS ≥3 that died		Patients with EWS ≥3 that that survived	
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
Age in years (all)	48 (22)	43 (31-99)	59 (23)	59 (40-82)	43 (20)	36 (27-54)
Age in years (male)	54 (21)	52 (37-71)	59 (21)	58 (40-75)	51 (21)	50 (35-69)
Age in years (female)	43 (22)	36 (27-58)	59 (25)	61 (42-85)	36 (17)	33 (24-43)
Length of hospital Stay (days)	14 (16)	10 (5-17)	12 (15)	8 (4-16)	16 (17)	11 (5-19)
Admission EWS	2.9 (1.7)		2.7 (1.7)		2.9 (1.8)	
EWS on inclusion Into study	4.1 (1.5)		4.5 (1.7)		3.9 (1.3)	
Maximal EWS	4.8 (1.7)		5.5 (1.8)		4.4 (1.5)	
Final EWS	1.8 (1.0)		4.3 (2.3)		1.8 (1.0)	

Demography of patients who scored ≥3. Women were younger than men 36 (IQR 27-58) vs 52 (IQR 37-71) and women who survived were younger than those who died 33 (IQR 24-43) vs 61 (42-85). Those who died lived for a week in hospital 8 (IQR4-16) and 6.5 (SD 7.0) after first scoring ≥3.

The 63 patients that died within the study population were medical patients(53; 84%), surgical(7;11%) and orthopaedic (3; 5%).All of the surgical patients (10) but only 44(83%)of the medical patients were seen by a specialist. The remainder (9) were seen only by medical officers. In 2 patients (3.2%) a second in-house specialist was consulted. There was a delay of 3.6 days (SD 3.9) before being seen by a specialist and these patients lived another 6.5 days (SD 7.0) on average before death. Only 3 patients (5%) were transferred to a referral hospital, one surgical and 2 medical patients. None of them was admitted to an intensive care unit. The most common diagnosis was respiratory illness (25; 40%). In 10 (16%) of them this was due to pulmonary tuberculosis. The other 3 most common diagnoses were anaemia (9), cerebral infections (8) and congestive heart failure (8). HIV prevalence among the patients that died was 37%. Other co-morbidities were rare with the exception of hypertension (21%). Cause of death was not clear in 60% of patients. When cause of death could be inferred from the clinical record, it was illness related in 75% of cases. None of these patients received CPR.

Of the 109 patients in the study population that survived, most were again medical patients (57; 52%), surgical (40; 37%) and orthopaedic (12; 11%). All the orthopaedic patients (12) were seen by the hospital specialist orthopaedic surgeon. The surgical (30; 75%) and medical patients (44; 77%) were seen by the hospital specialist. The remainder (10 surgical and 13 medical patients) were seen by medical officers only. In 6 patients (5.5%) a second in-house specialism was consulted. There was a mean delay of 4.1 days (SD 4.6) before being seen by a specialist. Only 3 patients (5%) were transferred to a referral hospital, 2 surgical and 1 medical. None of them was admitted to an intensive care unit. The most common diagnosis was again respiratory illness (37, 34%). In 11 of them this was due to pulmonary tuberculosis. Other common diagnoses were incomplete abortion (11), anaemia (10) and fractures. HIV prevalence was 40%, similar to the group that died. Other co-morbidities were again rare with the exception of hypertension (9%).

In only 6 out of the 60 patients that died in the hospital a rationale to continue treatment locally could be found in the clinical record, even though all these patients were deteriorating. The same was true for the patients that survived where on only 3 occasions a reason was made in the notes. Reasons for not referring were patient request (n=1), death during resuscitation (n=1), sudden deterioration (n=2) and refusal by the referral hospital (n=5). The reasons for transfer were unavailability of treatment (n=4) and social indication (n=2). Decisions to restrict care when patients were not transferred were only recorded in the notes of 2 patients, who both survived. Decisions to withdraw care were never recorded.

Discussion

According to our study, there are many adult medical and surgical patients 'at risk' of critical illness (21%) on the wards of our district hospital. This is based on a simple score of physiological parameters and seems to be confirmed by the high mortality of 37% of the patients in this group compared to the average of 8.1%. We were not able to assess the true prevalence of critical illness, based on organ failure as many laboratory tests are not readily available in our hospital. The assumption that all patients with deteriorating physiological parameters that die in our setting must be critically ill would be incorrect. Although unlikely, some critically ill patients may have survived their illness without access to ICU. The EWS will flag both groups.

The prevalence we calculated would also include patients not deemed eligible for escalation to intensive care treatment or patients that could have recovered with more appropriate care on the wards. Decisions regarding treatment limitation were hardly ever recorded so could not be analysed and the study did not assess the level of care patients were receiving. Paediatric and obstetric patients were not included as well as patients attending the accident and emergency room that were not admitted to a ward because they died during the resuscitation or were transferred to another hospital. This would raise the actual critical illness burden. Although unlikely, patients that did not trigger a score of 3 or more during their admission while being critically ill would not be identified as well.

The highest prevalence of being 'at risk' of critical illness is found under medical patients (30%) who also seem to fare the worst with an overall mortality of 14%. This rises to 48% (53 out of 110) when the EWS is 3 or more. The most common diagnosis was respiratory illness and aggressive respiratory support might have made a difference for those patients. The period between physiological deterioration (attaining an EWS of 3 or more) and death was nearly one week, which suggests that there was time for intensifying treatment to try to improve the outcome. The low referral rates in both survivors but especially in patients that died are in that respect surprising. Because clinical rationale was often not recorded in the notes, the underlying reason for this is not clear. Another surprising fact was that in 32 study patients (19%) no specialist was involved in the treatment. This was 14% of the patients that died (9) and 21% of the patients that survived (23). They were mostly medical patients. Specialist input might have made a difference.

The expected combined mortality, cardiac arrest and ICU admission rates for patients with EWS of 3-4 is 12.7% and if EWS 5-9 is 30%. The mortality rates found in this study compare unfavourably with a mortality of 22% for scores of 3-4 and 50% for scores 5-9. Differences in patient characteristics, quality of care on the wards or of the clinical decision-making by doctors could be responsible. What is clear however is

that this group of patients do a lot worse than expected. The unavailability of critical care and adequate transfer facilities could also be held accountable for that.

Most of the patients (94%) that died on the wards during the study period had an EWS score of 3 or more at some stage during their admission. This confirmed the usefulness of an EWS score to identify a population at risk. The score has to be done consistently and correctly, which was a problem in our hospital as it wasn't done in nearly one third of occasions and the calculations were incorrect in nearly half of them. During the study period rechecking and calculating missing scores compensated for this. It would affect the EWS as a tool however if these issues were not addressed. Doctors in Mahalapye Hospital do not use the EWS at the moment to prioritize medical care. This study shows the failure of other methods to timely identify poorly patients and implies that the EWS could be a useful addition.

Given the lack of resources it is not surprising that a cost intensive form of treatment like intensive care does not feature high on the health agenda of many Sub-Saharan countries. But even with early identification of patients at risk of critical events and intensification of treatment, it seems likely that the presence of a critical care area is necessary to address the needs of those that cannot be managed on the wards and are too unstable to be transferred. It would also offer the opportunity to provide outreach services and training of ward staff. The difficulties should not distract us from efforts to improve critical care in Africa.[15] A model of appropriate intensive care practice is sustainable although it should not seek to copy the developed world.[16] Even in low income countries a basic intensive care unit can reduce mortality and be cost effective and the concept of a primary intensive care is a logic development from the accepted primary anaesthesia and primary surgery concepts.[17] A basic high care unit in a secondary hospital in Cape Town admitted 16% of all medical admissions. A median stay of 2 days and a good patient outcome overall was reported.[18]

Conclusion

There was a considerable mortality among inpatients in our district hospital. Apart from estimating the prevalence of being 'at risk' for critical illness, this study has shown the failure to timely identify these patients. Using a simple tool like an EWS is a low cost and simple means of assessing the burden of critical illness and evaluate the type of care options for patients that are severely ill at district hospital level. Up till now neither the true numbers of critically ill patients in Sub Saharan Africa, nor their outcome without direct access to critical care are known. This study has been an attempt to quantify the problem but obviously more research into this area is needed. As an analogy with an 'unmet surgical disease burden',[19] one could speak about a 'critical care gap' where patients do not get the intensive care that they need.

Acknowledgements

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References

1. Fowler RA, Adhikari NKJ, Bhagwanjee S. Clinical review: critical care in the global context disparities in burden of illness, access and economics. *Critical Care*, London, England, 2008;12:225.
2. Baker T. Critical care in low-income countries. *Trop Med Int Health*, TM & IH 2009;14:143-8.
3. Razzak JA, Kellermann AL. Emergeny medical care in developing countries: is it worthwile? Bulletin of the World Health Organisation 2002;80:900-5.
4. Dunser MW, Baelani I, Ganbold L. A review and analysis of intensive care medicine in the least developed countries. *Critical Care Med* 2006;34:1234-42.
5. Bhagwanjee S. Critical care in Africa. *Critical Care Clinics* 2066;22:433-8, viii.
6. Mathivha LR. ICUs worldwide: an overview of critical care medicine in South Africa. *Critical Care* (London, England) 2002;6:22-3.
7. Wallis PA, Gottschalk SB, Wood D, *et al.* The Cape Triage Score: a triage system for South Africa. *SAMJ*=Suid-Afrikaanse tydskrif vir geneeskunde 2006;96:53-6.
8. Gottschalk SB, Wood D, DeVries S, *et al.* The Cape Triage Score: a new triage system South Africa. Proposal from the Cape Triage Group. *Emergency Med J* 2006;23:149-53.
9. Subbe CP, Kruger M, Rutherford P, *et al.* Validation of a modified Early Warning Score in medical admissions. *QJM* monthly journal of the Association of Physicians 2001;94:521-6.
10. Subbe CP, Davies RG, Williams E, *et al.* Effect of introducing the Modified Early Warning Score on clinical outcomes, cardio-pulmonary arrests and intensive care utilisation in acute medical admissions*. *Anaesthesia* 2003;58:797-802.
11. Stenhouse C, Coates S, Tivey M, *et al.* Prospective evaluation of a modified Early Warning Score to aid earlier detection of patients developing critical illness on a general surgical ward. *Br J Anaesth* 2000;84:663-.
12. Groarke JD, Gallagher J, Stack J, *et al.* Use of an admission early warning score to predict patient morbidity and mortality and treatment success. *EMJ* 2008;25:803-6.
13. Gardner-Thorpe J, Love N, Wrightson J, *et al.*

The value of Modified Early Warning Score (MEWS) in surgical in-patients: a prospective observational study. *Ann R Coll Surg Engl* 2006;88:571-5.
14. Rylance J, Baker T, Mushi E, *et al.* Use of an Early Warning Score and ability to walk predicts mortality in medical patients admitted to hospitals in Tanzania. *Trans R Soc Trop Med Hyg* 2009;103:790-4.
15. Amoaten-Adjepong Y. Caring for the critically in developing countries: our collective challenge. *Critical Care Med* 2006;34:1288-9.
16. Towey RM, Ojara S. Intensive care in the developing world. *Anaesthesia* 2007;62:Suppl 1:32-7.
17. Towey RM, Ojara S. Practice of intensive care in rural Africa: assessment of data from Northern Uganda. *Afr Health Sci* 2008;8:61-4.
18. vanZyl-Smit R, Burch V, Willcox P, *et al.* The need for appropriate critical care service provision at a non-tertiary hospitals in South Africa. *SAMJ=* Suid-Afrikaanse tydskrif vir geneeskunde 2007;97:268,270,272.
19. Weiser TG, Regenbogen SE, Thompson KD, *et al.* An estimation of the global volume of surgery: a modelling strategy based on available data. *Lancet* 2008;372:139-44.